

- 1 1. A method for aligning the optical elements which couples and focuses a diode
2 laser beam from a laser diode into an optical fiber, the method comprising the steps of:

3 determining a first set of angular and spatial tolerances applicable to the focused
4 laser beam entering the fiber,

5 determining a second set of angular and spatial tolerances for collimating the laser
6 beam by placing a lens in the laser diode beam such that a collimated beam is produced
7 and aligned to the axis of the fiber within the second set of angular and spatial tolerances,

8 determining a third set of angular and spatial tolerances for focusing the laser
9 beam onto the axis of the optical fiber within the third spatial tolerance by placing a
10 strong lens within the collimated beam within the third spatial tolerance, and

11 steering the laser beam onto the axis of the optical fiber within first spatial toler-
12 ance by placing a weak lens within the collimated beam within the third spatial tolerance.

1 2. The method as defined in claim 1 wherein the third spatial tolerance is at least ten
2 times larger than the first spatial tolerance.
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1 3. The method as defined in claim 2 where the first spatial tolerance is 0.1 micron
2 and the third spatial tolerance is 1.0 microns.
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1 4. The method as defined in claim 2 where the first spatial tolerance is 0.1 micron
2 and the second spatial tolerance is 10 microns.
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1 5. The method as defined in claim 1 wherein the second spatial tolerance is at least
2 one hundred times larger than the first spatial tolerance.
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1 6. The method as defined in claim 1 further comprising the steps of:
2 maximizing the energy output of the fiber to determine when the positioning, col-
3 limation, and focusing is optimum.

1 7. The method as defined in claim 1 wherein the focal length of the strong lens is
2 about 5 mm in conjunction with an axial tolerance of about 50 micrometers for the laser
3 beam incident upon the strong lens with respect to the optical fiber.

1 8. The method as defined in claim 1 further comprising the steps of:
2 placing a collimating lens axially aligned in parallel with the axis of the laser di-
3 ode, wherein the collimating lens performs the step of collimating the laser beam in par-
4 allel with the axis of the laser diode and the axis of fiber, and,
5 prior to placing the weak lens,
6 maximizing the output from the fiber by moving the strong lens in a direction
7 normal to the optical axis and by moving the fiber end along the optical axis, and
8 after placing the weak lens, maximizing the output of the fiber by moving the weak lens
9 in a direction normal to the optical axis and by moving the fiber end along the optical
10 axis.

1 9. A system for aligning the optical elements which couples and focuses a diode la-
2 ser beam from a laser diode into an optical fiber, the system comprising:

3 a first set of angular and spatial tolerances applicable to the laser beam entering
4 the fiber,
5 means for collimating the laser beam to the axis of the fiber within the second
6 spatial and angular tolerance,

7 a second set of angular and spatial tolerances for positioning the collimated laser
8 beam to the axis of the fiber,

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10 a third set of angular and spatial tolerances and a strong lens placed within the
11 collimated beam that focuses the collimated laser beam onto the axis of the optical fiber
12 within the third spatial tolerance, and

13 a weak lens placed, within the third spatial tolerance, within the collimated beam,
14 that steers the collimated laser beam onto the axis of the optical fiber within the first spa-
15 tial tolerance.

1 10. The system as defined in claim 9 wherein the third spatial tolerance is at least ten
2 times larger than the first spatial tolerance.

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1 11. The method as defined in claim 10 where the first spatial tolerance is 0.1 micron
2 and the third spatial tolerance is 1.0 microns.

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1 12. The system as defined in claim 10 where the first spatial tolerance is 0.1 micron
2 and the second spatial tolerance is 10 microns.

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1 13. The system as defined in claim 9 wherein the second spatial tolerance is at least
2 one hundred times larger than the first spatial tolerance.

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1 14. The system as defined in claim 9 further comprising:
2 means for maximizing the energy output of the fiber to determine when the posi-
3 tioning, collimation, and focusing is optimum.

1 15. The system as defined in claim 9 wherein the focal length of the strong lens is
2 about 5 mm in conjunction with an axial tolerance of about 50 micrometers for the laser
3 beam incident upon the strong lens with respect to the optical fiber.

- 1 16. The system as defined in claim 9 further comprising:
2 a collimating lens placed axially aligned in parallel with the axis of the laser diode
3 that collimates the laser beam in parallel with the axis of the laser diode and the axis of
4 the fiber, and,
5 with the weak lens removed, means for measuring and maximizing the output
6 from the fiber by moving the strong lens in a direction normal to the optical axis and by
7 moving the fiber end along the optical axis, and
8 after replacing the weak lens, means for measuring and maximizing the output of
9 the fiber by moving the weak lens in a direction normal to the optical axis and by moving
10 the fiber end along the optical axis.

- 1 17. A method for aligning the optical elements which couples and focuses a diode
2 laser beam from a laser diode into an optical fiber, the method comprising the
3 steps of:
4 determining a first set of angular and spatial tolerances applicable to the
5 focused laser beam entering the fiber,
6 collimating and focusing the laser beam to be aligned with and onto the axis
7 of the optical fiber within a third set of angular and spatial tolerances by placing a colli-
8 mating and a strong lens in the laser beam, and
9 steering the laser beam onto the axis of the optical fiber within first spatial toler-
10 ance by placing a weak lens within the collimated beam within the third spatial tolerance